CRETACEOUS AND TERTIARY FORAMINIFERA FROM THE MIDDLE EAST

BY

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By T. F. GRIMSDALE

(*With Plates 20–25*)

CONTENTS

SYNOPSIS

One new species is described and figured of each of the following genera: *Articulina*, *Austrotrillina* (?), *Heterillina*, *Idalina*, *Laffitteina*, *Saudia*, and a new variety of *Eorupertia incrassata* (Uhlig). Notes and figures of previously described species are also given.

A brief account of the stratigraphic occurrences and associated faunas of these species provides a background for the descriptive notes. Five of the species are from the Oligocene, seven from the Eocene, two from the Paleocene, and one from the Upper Cretaceous.

I. ACKNOWLEDGEMENTS

I wish to thank the Iraq Petroleum Company Limited for permission to publish these notes. More particularly, I am happy to acknowledge valuable help from colleagues on the Company's staff: Mr. G. F. Elliott kindly assisted in compiling plates and in checking the draft; Mr. A. H. Smout has discussed with me details of many species; Miss M. Seward has photographed a number of the specimens; and Dr. F. R. S. Henson made a point of insisting upon the publication of my manuscript names, and is, therefore, the moving spirit behind this account. I also wish to thank Mr. C. D. Ovey and Mr. F. M. Wonnacott of the British Museum (Natural History) for assistance in preparing the typescript for the press.

II. INTRODUCTION: FAUNAL ASSOCIATIONS OF SPECIES HERE DESCRIBED

The fifteen species here described do not comprise a single fauna, but are disposed over the sequence from Senonian to Oligocene; however, in most instances they form significant elements of faunas whose other components have been previously recorded. The following introductory notes will serve to indicate the significance of some of the species by discussing the faunas with which they are associated.

A. Oligocene Species

1. *Heterillina hensoni* sp. nov. and *Austrotrillina* (?) *paucialveolata* sp. nov. These two species occur in abundance and are important additions to a fauna, other elements of which have been described by Henson (1950), namely, *Archaias operculiniformis* Henson, *Peneroplis glynnjonesi* Henson, and *Praerhapydionina delicata* Henson.

This fauna occurs in limestone, with abundant Miliolidae, in wells at Kirkuk, Iraq. It underlies beds with *Austrotrillina howchini* (Schlumberger), *Peneroplis thomasi* Henson, and *Praerhapydionina delicata* Henson; and it overlies beds with *Nummulites fichteli* and *N. intermedius* of Lower Oligocene age.

2. *Nummulites vascus* Joly & Leymerie var. *semiglobulus* (Doornink). This form commonly accompanies *Nummulites fichteli*, *N. intermedius*, and *N. vascus* in the Oligocene of Kirkuk.

3. *Nummulites bouillei* de la Harpe. Known from the lowest beds of the Oligocene in Kirkuk.

4. *Lepidocyclina ephippioides* (Jones & Chapman). This species occurs at Kirkuk in beds with *Nummulites fichteli*, *N. intermedius*, and *Lepidocyclina dilatata* (Miche-

lotti), but the two Lepidocyclinae range into younger beds than the *Nummulites*, though still within the Oligocene, while *L. dilatata* at least continues into the Aquitanian.

B. Upper Eocene Species

1. *Spiroclypeus anghiarensis* (Silvestri). This species is associated with *Pellatispira madaraszi* (Hantken) in Kirkuk, and elsewhere with *Nummulites fabianii* Prever and other Upper Eocene forms. For instance, at Maaloula, north-west of Damascus, it occurs with the following fauna:

Asterigerina rotula (Kaufmann)
Asterocyclina sp.
Actinocyclina radians (d'Archiac)
Globorotalia cerroazulensis (Cole)
Hantkenina alabamensis Cushman
Nummulites fabianii Prever
Tubulostium cf. *spirulaea* (Lamarck)
Echinocyamus nummuliticus Duncan & Sladen
Almaena sp. nov.

and a rich fauna of small foraminifera.

2. *Asterigerina rotula* (Kaufmann). Occurs with the foregoing in the Upper Eocene, but ranges down into the Middle Eocene with *Nummulites perforatus*. It is a useful guide species often found entire in well cuttings, whereas the larger nummulites are generally broken.

C. Middle Eocene Species

1. *Nummulites perforatus* (de Montfort) var. Abundant in the Middle Eocene of Kirkuk, in association with *Nummulites discorbinus* (Schlotheim), *Alveolina elliptica* (Sow.), *Orbitolites complanatus* Lamarck, and *Fabiania cassis* (Oppenheim).

2. *Eorupertia incrassata* (Uhlig) var. *laevis* var. nov. Associated with many well-known Middle Eocene species, this variety is readily recognized in thin sections, and forms a useful small guide species which may be encountered entire in drill cuttings, in contrast with the larger nummulite species which are generally broken.

3. *Articulina amphoralis* sp. nov. Found in great abundance in an Eocene limestone in the southern desert of Iraq, about 160 miles west-south-west of the town of Basra. The associated fauna comprising *Peneroplis damesini* Henson, *Praerhapydionina huberi* Henson, and *Meandropsina williamsoni* (Henson) suggests a Middle Eocene age, though Upper Eocene is not excluded.

D. Lower Eocene Species

1. *Laffitteina vanbelleni* sp. nov. The range of this species as established to date is rarely known to overlap the ranges of *Nummulites discorbinus*, *Eorupertia incrassata* var. *laevis*, and *Fabiania cassis* on the one hand, or of *Heterostegina* cf. *ruida* and *Sakesaria cotteri* Davies on the other. It is found in one locality associated with

Nummulites planulatus (Lamarck) var. On the strength of these facts it is regarded as of Lower Eocene age—probably at the top of the Lower Eocene, but this is not yet proven. Its small size and strongly characteristic appearance in thin section make it ideal for correlation in drill cuttings.

2. *Heterostegina* cf. *ruida* Schwager. This species is believed to be of Lower Eocene age from its association with *Sakesaria cotteri* Davies and *Alveolina globosa* Leymerie, in beds lacking any of the conspicuous Paleocene forms listed below.

E. Paleocene Species

1. *Saudia labyrinthica* sp. nov. This species occurs in the following associations:

(*a*) Jebel Sinjar, Iraq. 'Sinjar Limestone.'
Alveolina globosa Leymerie
Alveolina ovulum Stache *in* Schwager
Alveolina cf. *primaeva* Reichel
Gen. nov., sp. nov. Smout, in press
Idalina sinjarica sp. nov.
Miscellanea miscella (d'Archiac & Haime)
Miscellanea stampi Davies
Opertorbitolites sp.
Rotalia cf. *trochidiformis* Lamarck
Saudia labyrinthica sp. nov.

(*b*) Bazian Pass, Iraq.
Alveolina globosa Leymerie
Assilina dandotica Davies
Gen. nov., sp. nov. Smout, in press
Miscellanea miscella (d'Archiac & Haime)
Ranikothalia nuttalli (Davies)
Ranikothalia sindensis (Davies)
Ranikothalia thalica (Davies)
Sakesaria cotteri Davies
Saudia labyrinthica sp. nov.

The 'Ranikot' aspect of the latter assemblage, and the species common to both, have influenced me in assigning them to Paleocene; the possibility of a Lower Eocene age must, however, be entertained.

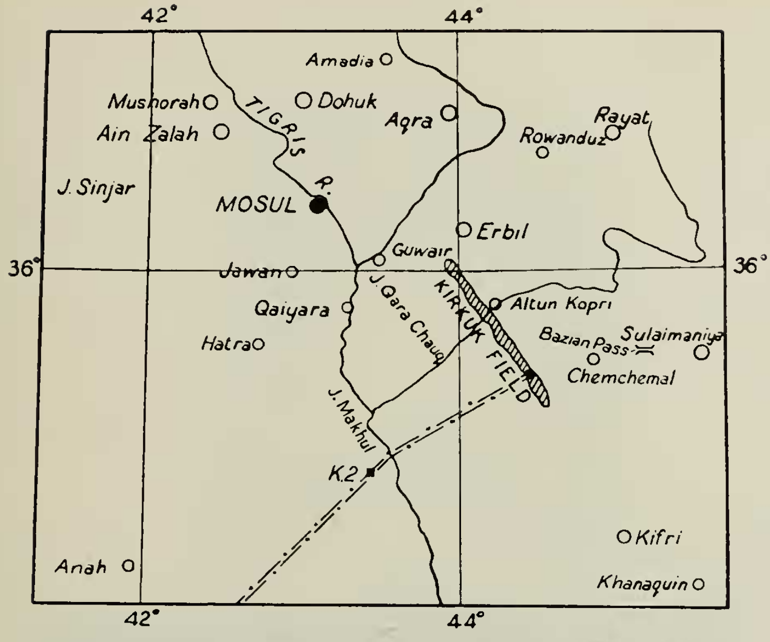
2. *Idalina sinjarica* sp. nov. This species has only been found at Jebel Sinjar.

F. Upper Senonian Species

Monolepidorbis douvillei Astre is believed to have existed prior to the *Omphalocyclus–Orbitoides–Siderolites* fauna of the Maestrichtian.

Most of the localities at which the various species are found may be seen on the map, Text-fig. 1.

The types and a representative series of specimens have been deposited in the British Museum (Nat. Hist.); Museum registration numbers are cited under each species.



Text-fig. 1. Map showing the localities from which the fossils were obtained.

III. SYSTEMATIC DESCRIPTIONS

Family MILIOLIDAE

Genus *ARTICULINA* d'Orbigny 1826

Articulina amphoralis sp. nov.

(Pl. 21, figs. 5–7; Pl. 23, figs. 9, 12–16)

Material. P. 40634–40645, P. 40710–40715.

Description. Test consisting of a coiled triloculine initial portion followed by a uniserial stage up to 5 chambers long, chamber walls longitudinally costate throughout. Serial chambers rather variable in shape, typically truncate-pear-shaped, but sometimes barrel-shaped, globose or elongated; the later chambers larger than the earlier ones. Aperture single, terminal, rounded or possibly stellate in shape, with a slight neck; the stellate appearance may be restricted to the intercameral foramina, or may be the inner part of a vestibular structure, but its existence is undoubted. It appears to be intimately connected with heavy internal fluting of the portions of the chambers adjacent to the intercameral necks.

Dimensions. (Maximum) length (5 serial chambers) 3·5 mm.; diameter of a serial chamber, 1·1 mm.; diameter of initial coiled portion, 0·88 mm.

Distribution. Abundant in an Eocene limestone in southern Iraq; associated fauna suggests either Upper or Middle Eocene. Type locality, near Chabd; lat. N. 29° 59′ 25″, long. E. 45° 16′ 30″, with *Peneroplis damesini* Henson, *Praerhapydionina huberi* Henson, *Meandropsina williamsoni* (Henson).

Remarks. *Articulina amphoralis* is larger and more robust than any other species of the genus so far described, and its chambers are typically less elongated than those of any other costate forms of the same genus, e.g. *A. nitida* d'Orb., *A. gibbulosa* d'Orb., *A. sagra* d'Orb., *A. conicoarticulata* (Batsch), *A. antillarum* Cushman, *A. terquemi* Cushman, &c. A few extreme variants in the populations of *A. amphoralis* have rather elongated chambers, but there is intergradation with the typical form; and specimens of these aberrant shapes are so few that no separate variety for them is considered justifiable.

I am indebted to Dr. F. R. S. Henson for part of the foregoing description, adapted from his unpublished manuscript.

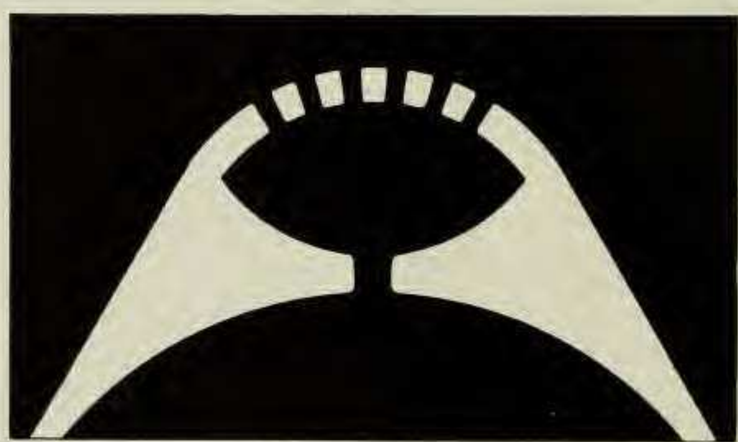
Genus ***HETERILLINA*** Munier-Chalmas & Schlumberger, 1905

Heterillina hensoni sp. nov.

(PL. 20, FIGS. 1–6; TEXT-FIGS. 2, 3)

Material. P. 40679, P. 40680 (i, ii), P. 40682.

Description. Test smooth, rather thick-walled, roughly circular, compressed, the individual chambers bulging. The early chambers are arranged in a quinqueloculine

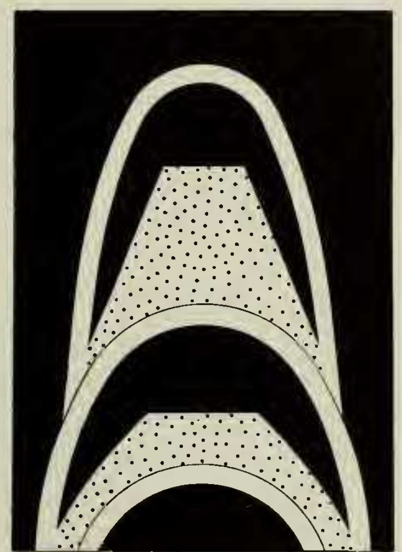


TEXT-FIG. 2. Diagrammatic reconstruction of a longitudinal section through the aperture of *Heterillina hensoni* sp. nov., to show the inferred vestibular lumen within the trematophore.

spiral; the later chambers are only two to a whorl and added in one plane, as in *Massilina*. Each chamber, however, has secreted a chamber wall complete on the inside as well as on the outside; on the inside it has formed a pronounced 'Platform', projecting into the chamber. Often there appear to be cavities between the inner wall of the later added chamber and the former outer wall of the preceding whorl. The aperture seems to be vestibular, with a trematophore, or perforated plate, covering a simple opening at the end of the last chamber.

Dimensions. Average of numerous specimens from Kirkuk wells K. 14, K. 18, K. 86. Diameter, 2·5 mm.; thickness, 0·75 mm.

Distribution. Miliola Limestone of Kirkuk field, in the Oligocene, where it is associated with *Austrotrillina* (?) *paucialveolata* sp. nov., *Archaias operculiniformis* Henson, *Peneroplis glynnjonesi* Henson, and *Praerhapydionina delicata* Henson.



TEXT-FIG. 3. Diagrammatic transverse section through two chambers of *Heterillina hensoni*, to show thickened inner walls of chambers forming 'platform'.

Remarks. The 'platform' is similar to the structure figured by Schlumberger in *Pentellina strigillata*. *Heterillina hensoni* somewhat resembles *H. guespellensis* Schlumberger, but lacks the surface ornament of that species; no 'platform' is figured in *H. guespellensis*.

Genus *AUSTROTRILLINA* Parr, 1942

Austrotrillina (?) *paucialveolata* sp. nov.

(PL. 20, FIGS. 7–10)

Material. P. 40681, P. 40689 (i, ii).

Description. Test ovate in longitudinal, sub-triangular in transverse section. Chambers added as in *Quinqueloculina*, which it resembles in all but the wall structure which is alveolar, the alveolae being coarser and less regular than in *Austrotrillina howchini*. Furthermore, a definite platform, or thickened inner wall, is sometimes visible, as noted in *Pentellina* by Schlumberger, and well developed in *Heterillina hensoni* sp. nov. as described above.

Dimensions. Length of test up to 2·5 mm.; width up to 1·25 mm.

Distribution. In the Miliola Limestone of Kirkuk oilfield, where it is associated with *Heterillina hensoni* and other species. Oligocene.

One of the specimens figured by Silvestri as *Trillina howchini* (1937, pl. 5, fig. 2), from Gotton, Somaliland, is probably this species; this locality is termed Miocene by Silvestri, but he adduces no supporting evidence for this age.

Genus *IDALINA* Munier-Chalmas & Schlumberger, 1884

Idalina sinjarica sp. nov.

(Pl. 20, figs. 11–14)

Material. P. 40672 (ii), P. 40706–40708.

Description. Test almost spherical in some specimens, but generally slightly longer in apertural than in transverse section. The early chambers show quinqueloculine coiling, reduced to biloculine in the adult; but the thickening of the inner walls of the chambers—resembling flosculinization—differentiates the species from a normal *Pyrgo*, though the coiling is similar. The inner, or flosculinized, wall of a chamber is normally at least 5 times as thick as the outer wall. The aperture is vestibular, with what may be a trematophoric plate covering a simple opening, at the end of the test, in the last chamber. No microspheric example has been observed, but one specimen (diameter 2·74 mm. plus) is so far beyond normal size that its microspheric character is suspected, though not determinable.

Dimensions. Maximum diameter 2·74 mm. plus (? microspheric). Average diameter of 8 known megalospheric individuals 1·3 × 1·4 mm. Two well-grown individuals showed dimensions of 1·63 × 1·63 mm. (transverse section) and 2·03 × 1·55 mm. (longitudinal section). Average diameter of nucleoconch 0·165 mm. (8 individuals). Normal wall thickness 0·025 to 0·030 mm. Flosculinized inner wall 0·125 to 0·2 mm.

Distribution. Paleocene limestone of Jebel Sinjar, north-west Iraq.

Remarks. There appear to be only two previously described species of *Idalina*, from both of which *I. sinjarica* differs, as follows: from *I. berthelini* Schlumberger (1905) in lacking striate ornament; from *I. antiqua* d'Orbigny (1884), principally in possessing much heavier thickening of the inner chamber walls. In both described species the initial chamber of the megalospheric generation is recorded as of considerably larger diameter (*I. antiqua*, 0·18 mm. to 0·44 mm.; *I. berthelini*, 0·23 mm. average) than has been found in the present species.

Family PENEROPLIDAE

Genus *SAUDIA* Henson, 1948

Saudia labyrinthica sp. nov.

(Pl. 21, figs. 1–4; Pl. 22, figs. 1, 2)

Material. P. 40646–40649, P. 40672 (i).

Description. Test compressed, biconcave, circular or oval, flat or somewhat undulating. Growth in the megalospheric form is annular throughout; details of the early stages in the microspheric form are unknown. The individual chambers of the annular portion are subdivided, but incompletely in that partitions do not break the continuity of the annular chamber to form chamberlets.

The external shell layer or epidermis is extremely thin, and is succeeded internally by a 'subepidermal layer' consisting of alveolar cellules formed by annular and radial partitions. Immediately within the epidermis the cellules are irregular, but are succeeded inwards by fairly regular square cellules, two radially per annular chamber, the radial partitions being staggered. Within the subepidermal layer lies a narrow zone in which the annular chambers are unpartitioned, wherein may be seen numerous stolons connecting each chamber with the two adjacent (proximal and distal) annulae; the stolons are at rather regular intervals.

Succeeding this 'open zone', and occupying up to $\frac{9}{10}$ths of the total thickness of the test, is a 'labyrinthic zone', consisting of a mass of shell substance riddled with irregular passages and channels, radial, annular, and transverse, of which the radial are the most continuous and persistent, the annular and transverse being for the most part short and discontinuous.

The 'labyrinthic zone' has evidently developed from a series of pillars and buttresses connecting the annular walls of the chambers, since it thickens distally from a mere median layer of pillars near the nucleoconch to occupy most of the thickness of the test peripherally in adult specimens; the epidermis, the 'subepidermal layer', and the 'open zone' remain constant in thickness from the earliest annuli to the periphery.

As a result of this labyrinthic structure, the continuity of individual chambers and chamber walls is lost in the equatorial layer of the test. Communication with the exterior was probably achieved by numerous apertures on the peripheral face of the outermost chamber, but these have not been actually observed, and their arrangement is therefore unknown.

Dimensions. Diameter: maximum 21×16 mm., other specimens of 6·5 mm., 7 mm., 9 mm., 10 mm. Thickness at edge, 0·6 mm. to 1·23 mm. Subepidermal alveolae, from 0·02 to 0·035 mm. About 13 annular chambers occupy 1 mm., measured along a radius. Diameter of megalospheric nucleoconch, about 0·5 mm. Thickness of epidermis, 0·005 mm. approx. Thickness of subepidermal layer, 0·040 to 0·050 mm. approx.

Distribution. Paleocene of Iraq.

Remarks. There is a general resemblance between *Saudia labyrinthica* and *Orbitopsella praecursor* (Gümbel), only the latter lacks the finely cellular subepidermal layer. The species *Orbitolites pharaonum* Schwager (1883) deserves re-study, since there is a similarity between Schwager's inadequate figures and *Saudia labyrinthica* which may not be due to homoeomorphy since both occur at horizons low in the Paleogene.

Saudia labyrinthica differs from *S. discoidea* Henson in one respect only, namely, the immense distal thickening of the equatorial layer; *S. discoidea* shows a similar but much less pronounced increase in thickness peripherally.

Family NONIONIDAE

Genus *LAFFITTEINA* Marie, 1946

Laffitteina vanbelleni sp. nov.

(Pl. 22, figs. 3–11)

1949 *Elphidium* sp. 1: Cuvillier & Szakall, p. 92, pl. 31, fig. 21 (5 views).

Material. P. 40677 (i, ii), P. 40678, P. 40690–40694.

Description. Test planispiral or almost so, of about 2½ whorls, stoutly lenticular to subglobular, margin subacute or rounded. The external surface is coarsely reticulate, the reticulations being formed by the walls of canals which open to the surface; over the centre of the test these canals are normal to the surface, but over the chambers of the embracing outer whorl they are oblique and display a chevron design, following the sutures, which may be observed sometimes on the external surface of the test or in sections close to the surface; this appears to be due to their diverging from their origin in the intraseptal canal system.

The chambers are equitant, but the alar prolongations do not extend far towards the poles, thus leaving a wide umbilical area which is filled with shell material, but spongy with radial canals. The aperture has not been observed, but normal intercameral foramina, at the inner ends of the septa as in *Nummulites*, seem to be present. There are from 14 to 16 chambers in the last whorl of a fully grown specimen.

As stated above, the radial canals which are so characteristic of the species seem to originate in the intraseptal canals. The latter merge proximally, and perhaps distally, in a spiral canal which presumably follows the marginal cord, though on this point precise observation is lacking.

Dimensions. Diameter about 1·5 mm. Thickness about 0·7 mm. Diameter of radial canals, 0·01 to 0·03 mm.

Distribution. In shallow-water limestones of Lower Eocene age in northern Iraq and in Syria; also in the Lower Eocene clays of Gan, south France.

Remarks. Marie (1946) describes the genus *Laffitteina* as being characterized by bilateral asymmetry; in *L. vanbelleni* this is not certainly observable, and if present is very slight. *Laffitteina vanbelleni* differs from *L. bibensis* Marie—the genotype species—in possessing fewer whorls, and fewer chambers per whorl, at a comparable diameter. In vertical sections the two species show remarkable resemblance to one another, and it is possible that *L. vanbelleni* is indeed merely the megalospheric form of *L. bibensis*. The stratigraphic implications of such an identity are interesting, since *L. vanbelleni* cannot possibly be older than Lower Eocene in its known occurrences, while the 'Calcaire pisolithique' of the Paris basin—whence comes *L. bibensis*—is reputed to be of Paleocene age.

Lastly, I am dissatisfied with Marie's reference of his genus *Laffitteina* to the family Nonionidae, but reluctant to propose any alternative. Its most striking resemblances are to *Elphidium* on the one hand and to *Pellatispira glabra* Umbgrove on the other, but close relationship with either will be difficult to prove.

Family NUMMULITIDAE

Genus *NUMMULITES* Lamarck, 1801

Amongst the vast literature of the nummulites, with its plethora of specific and varietal names, one finds a relatively small number of basic types appearing over and over again. These 'basic species' may frequently be distinguished from one another without resort to numerical or statistical examination, and sometimes even a single specimen is sufficient for identification. On the other hand, it may be possible to perform, perhaps in a single population of specimens basically alike, a separation into two or more collections distinguishable from each other by some observable minor distinction; these collections may either be rather sharply different—in any particular assemblage under examination—or they may be linked by a complete series of gradational forms. However, no two populations, unless stratigraphically and geographically close, are likely to provide precisely similar sub-populations. If each sub-population is to constitute a separate species, then the number of species will tend to approach or even to exceed the number of populations examined. This is what has happened all too frequently, though not invariably, so that we are burdened with a great number of species of extremely unequal worth, since some are based upon much narrower standards of discrimination than others. In fact, this is but another aspect of the old quarrel—'Lumpers' versus 'Splitters'.

The view is taken here that for a practical stratigraphic approach, the 'lumpers'' attitude is more likely to yield valid results if it be remembered that the wider interpretation of species will connote a longer geological range as well as a wider geographical range. This sounds equivocal, since a short geological range is generally a desideratum from the point of view of the stratigrapher; but where the geographical range is also small—as is frequently the case with the narrowly interpreted species of the 'splitters', in many cases confined to a very limited area indeed—the correlative value is proportionately reduced.

If these 'splitters' species' be regarded as mere races, of geological or geographical significance, then, within the wider geological range of the 'lumpers'' species, such races may be proved to have a locally restricted geological range; but their conspecificity may be valuable in a more than local sense.

In other words, if species *a*, *b*, and *c* are described from three different areas, nothing is added to our knowledge except that species *a* occurs at *X*, species *b* occurs at *Y*, and species *c* at *Z*. But if these three species be recognized as local races of the well-known Upper Eocene species *P*, then we have a strong presumption in favour of an Upper Eocene age for localities *X*, *Y*, and *Z*.

The foregoing provides a key to the interpretations of two of the three Nummulites recorded below. It applies with similar force to *Lepidocyclina ephippioides*, and in fact to almost any fossil organisms of great but finite variability and wide geographical distribution.

Nummulites bouillei de la Harpe

(Pl. 24, figs. 9–11)

1879 *Nummulites bouillei* de la Harpe, p. 60.
1879*a* *Nummulites bouillei* de la Harpe, p. 142, pl. 1, fig. I, 1–3.
1879*a* *Nummulites tournoueri* de la Harpe, p. 143, pl. 1, fig. II, 4–7.
1911 *Nummulites bouillei* de la Harpe: Boussac, p. 45, pl. 5, fig. 4 (useful synonymy).
1935 ? *Nummulites bouillei* de la Harpe: Cizancourt, p. 756, pl. 46, fig. 4.

Material. P. 40669, P. 40671, P. 40673.

Dimensions of Kirkuk specimens. Diameter, maximum 5·0 mm., minimum 3·0 mm. Diameter of nucleoconch, about 0·15 mm. 28–32 chambers in 6th whorl of B-form.

Remarks. I have figured some specimens from Kirkuk, which agree reasonably well with the type description, though the curvature of the septa is greater than is indicated in de la Harpe's rather stylized figures; they are, however, what Boussac describes as 'arquées plus ou moins brusquement dans leur partie périphérique'.

I am inclined to suspect that Mme de Cizancourt's figure (1935) represents an *Operculina*; her neglect to illustrate the critical transverse section must leave this unsettled.

Distribution. Widespread in Europe and the Middle East, in Upper Eocene and Oligocene.

Nummulites perforatus (Montfort) var.

(Pl. 25, figs. 3–9)

1808 *Egeon perforatus* Montfort, pp. 166–167.
1883 *Nummulites perforata* Orb. [*sic*] var. *uranensis* de la Harpe, opp. pl. 3; pl. 3, figs. 1–3 (Non *Nummulina uroniensis* de la Harpe) em. Heim, 1908, p. 226.
1911 *Nummulites bayhariensis* Checchia-Rispoli, p. 131, pl. 4, figs. 9–11.
1938 *Nummulites lucasi* d'Archiac var. *bayhariensis* Checchia-Rispoli: Flandrin, p. 47, pl. 3, figs. 67–70.
Compare also
1911 *Nummulites perforatus* Montfort: Boussac, p. 66.
1948 *Nummulites perforatus* Montfort: Van Andel, p. 1013, text-figs.

Material. P. 40650–40658, P. 40665 (i), P. 40666, P. 40670, P. 40676.

Description. The two generations differ enormously from one another, agreeing only in their generic characters and in possessing pillars; in fact, only their frequent association, combined with the knowledge that such dissimilar pairs are frequent among the larger and more complex Middle Eocene nummulites, can be cited in favour of assuming their relationship.

The B-form has a rather compressed lenticular test, with filaments which are radiate and 'tourbillonantes' (vortex-like) in the young, tending to become meandrine in the adult. Pillars are usually but slightly expressed on the surface but lie both between and attached to the filaments. The spire consists of chambers which are approximately as long as they are high in the early whorls, but with a tendency to be longer relatively in the later whorls. It resembles that of *N. perforatus* and *N. javanus* amongst others.

The megalospheric form is stoutly lenticular, about ¼ or ⅕ the diameter of the microspheric, and possesses large prominent pillars of which the largest are mostly towards the central umbones of the test and appear on the surface as strong pustules. Where the filaments are visible they appear to form a reticulate mesh with markings on the surface which follow the spire of the inner whorls and link the pillars in an obscurely spiral trend. These reticulations are vaguely similar to those observed in *Nummulites fabianii*, but the two species cannot be confounded with each other on account of the striking difference in size of the megalospheric initial chambers; in general also *N. fabianii* possesses a less bulky and more regular spiral lamina.

In equatorial section the spire of *Nummulites 'bayhariensis'* is approximately similar to that of megalospheric *N. perforatus* or to that of the accompanying microspheric specimens at a comparable size; but there is no very striking characteristic to relate it to one or the other, or to differentiate it markedly from examples of *N. atacicus* with abnormally widely spaced septa—except for the presence of pillars.

Dimensions. B-form: The microspheric examples from Kirkuk show the following dimensions: Maximum observed diameter 2·5 cm. At a diameter of 2 cm. there are approximately 17 whorls, but the twisting of the test will not allow of accurate counts.

A typical example provided the following data:

At radius of		0·16 cm.,	4	whorls with	7	chambers	per	quadrant
,,	,,	0·4	,,	8	,,	,,	11	,,	,,	,,
,,	,,	?	,,	9	,,	,,	14	,,	,,	,,
,,	,,	0·6	,,	10	,,	,,	14	,,	,,	,,
,,	,,	?	,,	11	,,	,,	15	,,	,,	,,
,,	,,	?	,,	12	,,	,,	17	,,	,,	,,

The ratio of diameter to thickness varies considerably from about 7:1 to 3·5:1, mostly being about 5:1.

A-form: The megalospheric specimens from Kirkuk have these measurements: Maximum diameter 5·0 mm. for a thickness of about 3·0 mm.; at diameter of 4·5 mm. there are 4 whorls. Septa per whorl, 8–9, 16, 24–28, 32. Diameter of nucleoconch generally from 0·9 to 1·0 mm., but occasionally smaller.

Remarks. The presence in the Middle Eocene of Kirkuk of abundant nummulites assignable to Checchia-Rispoli's species *N. bayhariensis*, in close association with a microspheric form clearly no more than a variety of *N. perforatus*, suggested that these might be megalo- and microspheric forms of a single species or variety The strongly turbinate pattern of the septal filaments of the microspheric partner caused me to regard it at first as a new species, but the appearance of Van Andel's work (1948) with its figures—especially text-fig. 1 of 'Forma B. var. 1'—provided a clue as to its true identity.

Some months later my colleague Mr. A. H. Smout was restudying some of the nummulites and came to the conclusion that *N. bayhariensis* should be regarded as at least a valid variety of *N. perforatus*, since it shows constant features which differentiate it from the typical form of the megalospheric partner in that species. At the same time he discovered that Boussac (1911: 74) had described a variant of *N. perforatus* in the following terms: 'Les *filets* sont susceptibles aussi de très grandes variations; ils peuvent rester rayonnants et seulement ondulés dans l'adulte, comme dans la race *uranensis* de la Harpe.'

On referring to de la Harpe's figures of *N. perforata* var. *uranensis*, Smout found that the rather diagrammatic drawings of this variety represent a form with turbinate filaments and equatorial section reasonably resembling those of the Kirkuk microspheric examples. This seems to confirm my former conclusion that the Kirkuk nummulites now under discussion are closely related to *N. perforatus*. It remained, then, to decide which name to apply to them, and the question at once arises: 'Does this association of "*N. uranensis*" and "*N. bayhariensis*" which in the Middle Eocene of Kirkuk is a strikingly obvious partnership, constitute a true and constant variety of the species *N. perforatus*, or is it a purely fortuitous concurrence of two particular variants of their respective generations?' The present answer to this question is simply 'We don't know', and it may take many years' observation to provide an answer. For this reason the question of a valid varietal name is left unsolved, but it would be perfectly reasonable to apply one or the other or both—at least in the present state of nummulite nomenclature. The fact remains that, for practical purposes, these forms are quite properly regarded as *Nummulites perforatus* (Montfort) var.

Boussac regards Heim's *N. uroniensis*—ascribed by its author to de la Harpe—as distinct from the latter's *N. uranensis* after which it was named, though the difference is less than specific since he equates *N. uroniensis* with *N. perforatus* (1911: 73).

Distribution. Nummulites perforatus has a wide distribution in the Eocene of the Tethyan belt, being known from Spain and Morocco in the West to Java (at least) in the East. The variant termed '*N. bayhariensis*' has been recorded from Algeria, Italy, and Somaliland, and now from Kirkuk, Iraq. The form '*N. uranensis*' was described from Switzerland, its only recorded locality previous to the present examples. The two in association have not yet been cited except at Kirkuk.

Nummulites vascus Joly & Leymerie var. ***semiglobulus*** (Doornink)

(Pl. 24, fig. 16; Pl. 25, figs. 1, 2)

1848 *Nummulites vasca* Joly & Leymerie, p. 171, pl. 1, figs. 15–17; pl. 2, fig. 7.
For synonymy see Boussac, 1911, p. 35 (*Nummulites vascus*) and p. 32 (*Nummulites incrassatus*).

1906 *Nummulites* (*Paronaea*) *rosai* Tellini var. *obesa* Parisch, p. 78, pl. 1, figs. 22–24.

1932 *Camerina semiglobula* Doornink, pp. 292, 308, pl. 7, figs. 1–14; text-figs. *d*, *e* on p. 293.

Material. P. 40659–40663.

Description. Exceptionally stout and thick-walled microspheric variants of the group of *Nummulites vascus–N. incrassatus* are seen frequently in the Oligocene of Kirkuk, in association with larger and more compressed lenticular microspheric forms referred to *N. vascus* s.s. The megalospheric partners of these two forms have not been distinguished from one another, being assigned simply to *Nummulites* group *vascus*.

These forms have Eocene homoeomorphs in the group of *Nummulites atacicus* Leymerie, from which they are doubtfully distinguishable by a somewhat inconstant difference in the curvature of the septa.[1] This distinction is unsafe for stratigraphical recognition.

This variety is only recognizable in transverse sections.

Dimensions. Diameter reaching 5 mm., thickness about 3 mm.

Distribution. Oligocene of Kirkuk, Iraq; Upper Eocene of Java; Oligocene of Liguria, Italy.

Remarks. Many records of *Nummulites incrassatus* de la Harpe may refer to this form. *N. rosai* Tellini is placed by Boussac in the synonymy of *N. incrassatus*, and Parisch's variety *obesa*, being a homonym, cannot be employed. Doornink's species is therefore reduced to varietal status to comprise such stout radiate forms as these. It is quite reasonable to expect that, sometime, an earlier name for them may be exhumed from the literature to invalidate that of Doornink.

Genus ***HETEROSTEGINA*** d'Orbigny, 1826

Heterostegina sp. cf. ***Heterostegina ruida*** Schwager

(Pl. 24, figs. 3–8)

Compare 1883 *Heterostegina ruida* Schwager, p. 145, pl. 29, fig. 6*a–e*.
and 1937 *Heterostegina* cf. *ruida* Schwager: Davies, p. 52, pl. 5, fig. 21.

Material. P. 40674 (i, ii), P. 40675, P. 40698–40700.

Description. Test small, flat, of variable outline from nearly circular to elongate oval; there is a slight central thickening over the initial chamber.

The Iraq specimens here figured resemble Schwager's species fairly closely, as may be seen from the figures and the dimensions; but since the external features are unknown in the Iraq species, comparison is incomplete. Furthermore, the Iraq species exhibits a characteristic which distinguishes it from all other described forms of *Heterostegina*, in that the secondary septa possess distal stolons connecting adjacent chamberlets of the same chamber with one another; while no such feature is described for *Heterostegina ruida* from Egypt, this is no evidence of its absence therefrom.

Dimensions. Diameter up to 2·3 mm. Thickness up to 0·4 mm. at the centre of the test.

Distribution. The type specimens of *Heterostegina ruida* were described from the Libyan stage of Egypt, alleged to comprise Paleocene and Lower Eocene.

Heterostegina cf. *ruida* is recorded by Davies from the Sakesar limestone of the Punjab Salt Range, placed by him in the Laki (Lower Eocene); it is associated therein with species of *Assilina* and *Nummulites*, of *Lockhartia* and *Alveolina*, including *Alveolina globosa*, and with *Sakesaria cotteri*.

The Iraq examples are from the Lower Eocene of Mushorah well No. 1 (N. Iraq), where they are associated in drill cuttings with *Alveolina globosa*, *Sakesaria cotteri*, and species of *Nummulites* and *Orbitolites*.

[1] In the Oligocene forms the septa in median section tend to be approximately radial for the inner ½ to ⅔ of their length, being sharply reflexed in the outer portion, until in extreme examples they run almost parallel with the periphery. In the Eocene forms such as *Nummulites atacicus* s.s. the septa are inclined and gently curved throughout their length.

Genus *SPIROCLYPEUS* H. Douvillé, 1905

Spiroclypeus anghiarensis (Silvestri)

(PL. 24, FIGS. 12–15)

1907 *Heterostegina anghiarensis* Silvestri, p. 56, pl. 2, figs. 6, 7.

Material. P. 40633, P. 40683 (i, ii), P. 40688 (i, ii).

Description. Test very flattened, with a pronounced central boss on each side of the megalospheric nucleoconch; such a boss is probably lacking from the microspheric form. The megalospheric test consists of two or three whorls, opening very rapidly in a flaring manner. Equatorial section is normal heterostegine, but the available material shows little detail and full description must await better specimens. There are only two or three tiers of lateral chambers which appear in vertical section as lines of 'dashes', since they are extremely low in comparison with the height of the roofs and floors, being less than 0·01 mm. in height.

Dimensions. Maximum diameter at least 4·5 mm. Average diameter of 13 specimens, some incomplete, 2·5 mm. Maximum thickness observed 0·79 mm., measured on a broken specimen of diameter 3·2 mm.

Distribution. Silvestri's types are stated to be from the Tongrian of Arezzo, Italy, but no supporting evidence for this age is adduced in his 1907 paper. In the Middle East, specimens occur in the Upper Eocene of Kirkuk field associated with *Pellatispira madaraszi* (Hantken) and *Discocyclina* sp.; in the Upper Eocene of Maaloula, near Damascus, Syria, associated with a rich fauna of large and small foraminifera; in the Upper Eocene of Jebel Hafit, Oman (Arabia), with *Nummulites fabianii* Prever; and at Cheikh Keuy, Syria.

Remarks. This seems to be the most compressed species of *Spiroclypeus* so far encountered, besides being distinguished from other described species by the extreme narrowness of its slit-like lateral chambers See also note on p. 247.

Family AMPHISTEGINIDAE

Genus *ASTERIGERINA* d'Orbigny, 1839

Asterigerina rotula (Kaufmann)

(PL. 23, FIGS. 10, 11; PL. 24, FIGS. 1, 2)

1867 *Hemistegina rotula* Kaufmann, p. 150, pl. 8, fig. 19*a–e*.
1868 *Rotalia campanella* Gümbel, p. 650, pl. 2, fig. 86*a–e*.
1883 ? *Asterigerina* ? *lancicula* Schwager, p. 127, pl. 28, figs. *a–d*.
1886 *Pulvinulina rotula* (Kaufmann) Uhlig, p. 193, pl. 3, fig. 5*a–c*; pl. 5, figs. 6, 7.

Material. P. 40665 (ii, iii), P. 40702, P. 40703, P. 40709.

Description. Test approaching hemispherical shape, slightly convex dorsally, extremely inflated ventrally, periphery rounded, surface smooth. The sutures, when visible, are not strongly retrorse nor sharply reflexed dorsally, and on the ventral side they bifurcate approximately half-way between the periphery and the large umbonal plug which is always pronounced. The shell substance of the outer wall is fully perforate. The septa appear almost radial, and in correctly oriented sections are opposed by hook-like counter-septa, reminiscent of those described in *Amphistegina lopeztrigoi* Palmer, *Helicostegina*, and *Eulinderina* (Barker & Grimsdale, 1936: 233 *et seq.*). The aperture lies approximately at the junction of the septal face with the previous whorl, below the periphery.

Dimensions. Diameter of test up to 1·5 mm.

Distribution. Described originally from Switzerland, it is reported by Uhlig from west Galicia (Poland); Schwager's *Asterigerina* ? *lancicula* is from the Mokattam stage of Egypt. The occurrences reported here are from Kirkuk, Iraq (Upper and Middle Eocene), and from near Damascus, Syria, in the Upper Eocene.

Remarks. This species has a vertical section which is highly characteristic in rock slices; the limits of its range have not yet been clearly established, but it seems to be restricted to the Upper Eocene and the upper part of the Middle Eocene.

Family VICTORIELLIDAE

Genus ***EORUPERTIA*** Yabe & Hanzawa, 1925

Eorupertia incrassata (Uhlig) var. ***laevis*** var. nov.

(Pl. 20, figs. 15–21)

Compare 1886 *Rupertia incrassata* Uhlig, pl. 4, fig. 5 only.

Material. P. 40695–40697, P. 40701, P. 40704, P. 40705.

Description. Test coiled, consisting of about 2 whorls, the dorsal or attached side flat or slightly concave, the ventral or free side sub-conical with convex slopes and a small concave umbilicus truncating the summit; the shape approximates to that of a skep (woven straw beehive). The second whorl has from 10 to 12 chambers. The coiling is loose, and although the second whorl more or less embraces the inner whorl on the free side of the test, there appears to be a definite lumen between the whorls into which the chambers open. The last few chambers are usually separated from the surface of attachment and show a tendency to flare on the free side. The surface of the test is coarsely perforate, but almost smooth, lacking the tubercles seen in *Eorupertia incrassata* and other described species of *Eorupertia*; and alternating series of irregularly radiating ridges and slits are seen in the umbilical depression, the slits probably communicating with the internal lumina.

Dimensions. Maximum diameter about 2·5 mm.; height approximately equal to diameter.

Distribution. Iraq, east Arabia, Oman, Turkey; apparently restricted to the Middle Eocene. Specimens from the Upper Lutetian of France (Grande Carrière, Lassalle, Landes; and St. Martin de Hinx, well A, at 37 m.) in the British Museum (Natural History) undoubtedly belong to this variety.

Remarks. The smooth specimen figured by Uhlig (1886) closely resembles specimens from the Iraq Middle Eocene which are consistently smooth, tuberculate ornamentation being exceptional; on this ground the erection of a new variety is believed justifiable.

Family ORBITOIDIDAE

Genus *MONOLEPIDORBIS* Astre, 1928

Monolepidorbis douvillei Astre

(Pl. 23, figs. 1–7)

1906 *Linderina* sp.: H. Douvillé, p. 601, pl. 18, fig. 18.
1928 *Monolepidorbis douvillei* Astre, p. 390.
1936 *Monolepidorbis douvillei* Astre: Reichel, p. 44, pl. 4, figs. 1, 5.
1948 *Orbitoides media* (d'Archiac): Silvestri, p. 84 (156), pl. 7 (15), figs. 4–7.

Material. P. 40684–40687 in the British Museum collections; additional sections in the Iraq Petroleum Company's Geological Research Centre.

Description. Test depressed conical in form, consisting of an equatorial layer of chambers disposed in a flat cone and cyclically arranged about a nucleoconch which appears to be two-chambered and sandwiched between layers of densely perforated shell substance thick over the centre but thinning peripherally. The equatorial chambers appear arcuate in equatorial section; each chamber is connected with adjacent chambers of the previous and subsequent cycles by means of diagonal stoloniferous passages which are circular in cross-section and disposed in two or three tiers—as may be observed in transverse sections. The appearance of transverse sections recalls in all respects—except for the absence of lateral chambers—species of the genus *Orbitoides* rather than of *Lepidorbitoides* or *Lepidocyclina.* The surface ornament has not been observed, but probably consists of pustules, perhaps elongated radially as in *Orbitoides faujasi* and *O. media.*

Dimensions. Average diameter (12 individuals) 1·5 mm. Maximum diameter observed 2·1 mm. Maximum thickness observed 0·62 mm. Equatorial chambers: radial diameter about 0·1 mm. Annular diameter about 0·13 mm. Height 0·1 to 0·15 mm.

Distribution. Originally described from the Campanian of France; specimens here referred to this species abound in the Upper Senonian of Iraq. The examples figured by Silvestri (1948) as *Orbitoides media* purport to be from the Maestrichtian of northern Somaliland.

Remarks. The specimens above described are probably all megalospheric, but the nucleoconch is in no case sufficiently clearly observed to warrant an illustration. It may, however, be stated with certainty that there is no large thick-walled nucleoconch of the type known in *Orbitoides,* but a small two-chambered affair apparently resembling either *Orbitocyclina* or *Lepidorbitoides.*

Genus *LEPIDOCYCLINA* Gümbel, 1868

Lepidocyclina ephippioides (Jones & Chapman)

(Pl. 23, figs. 8, 17, 18)

1900 *Orbitoides* (*Lepidocyclina*) *ephippioides* Jones & Chapman, pp. 251–252, 256, pl. 20, fig. 9; pl. 21, fig. 15.
1900 *Orbitoides* (*Lepidocyclina*) *andrewsiana* Jones & Chapman, p. 255, pl. 21, fig. 14.

1900 *Orbitoides* (*Lepidocyclina*) *insulae-natalis* Jones & Chapman, pp. 242, 256, pl. 20, fig. 5; pl. 21, fig. 13.
1900 *Orbitoides* (*Lepidocyclina*) *insulae-natalis* Jones & Chapman var. *inaequalis* Jones & Chapman, p. 254, pl. 21, fig. 12.
1900 *Orbitoides* (*Lepidocyclina*) *murrayana* Jones & Chapman, pp. 252–253, pl. 21, fig. 10.
1902 *Lepidocyclina formosa* Schlumberger, p. 251, pl. 7, figs. 1–3.
1904 *Lepidocyclina raulini* Lemoine & Douvillé, p. 11, pl. 1, figs. 3, 6, 9, 13, 16; pl. 2, figs. 3, 10; pl. 3, figs. 4, 14; text-fig. 2.
1906 *Orbitoides richthofeni* Smith, p. 205, pl. 1, figs. 1, 2.
1907 *Orbitoides* (*Lepidocyclina*) *inflexa* Checchia-Rispoli, p. 164.
1909 *Orbitoides* (*Lepidocyclina*) *inflexa* Checchia-Rispoli, p. 101, pl. 5, figs. 8, 9.
1909 *Lepidocyclina formosa* Schlumberger: R. Douvillé, p. 135, pl. 6, fig. 1.
1911 *Lepidocyclina* (*Eulepidina*) *inermis* H. Douvillé, p. 72, pl. D, fig. 5.
1911 *Lepidocyclina* (*Eulepidina*) *formosa* Schlumberger: H. Douvillé, p. 72, pl. D, figs. 2–4.
1911 *Lepidocyclina insulae-natalis* (Jones & Chapman) H. Douvillé, p. 71, pl. B, figs. 1–3.
1914 *Lepidocyclina sumatrensis* (Brady) var. *inornata* Rutten, p. 294, pl. 22, figs. 6–8.
1915 ? *Lepidocyclina verbeeki* (Newton & Holland) var. *papuaensis* Chapman, p. 297, pl. 8, figs. 5, 6; pl. 9, fig. 10.
1919 *Lepidocyclina crassata* Cushman, p. 61, pl. 11, figs. 4, 5; text-fig. 8.
1919 *Lepidocyclina favosa* Cushman, p. 66, pl. 3, figs. 1*b*, 2; pl. 15, fig. 4.
1919 *Lepidocyclina* (*Eulepidina*) *gibbosa* Yabe, p. 46, pl. 6, figs. 3, 4*c*, 7*c*.
1919 *Lepidocyclina* (*Eulepidina*) *monstrosa* Yabe, p. 42, pl. 6, fig. 5*a*; pl. 7, figs. 11, 12*a*, 13.
1919 *Lepidocyclina* (*Eulepidina*) sp. indet. cfr. *inermis*: Yabe, p. 46, pl. 7, fig. 2.
1919 *Lepidocyclina insulae-natalis* (Jones & Chapman): Yabe, p. 44.
1920 *Lepidocyclina chattahoocheensis* Cushman, p. 65, pl. 23, figs. 1–4; pl. 24, figs. 1, 2.
1924 *Eulepidina formosa* (Schlumberger): H. Douvillé, p. 49, pl. 2, fig. 1.
1925 *Lepidocyclina* (*Eulepidina*) *dickersoni* Yabe & Hanzawa, p. 104, pl. 25, figs. 10, 11.
1925 *Eulepidina formosoides* H. Douvillé, p. 71, pl. 3, figs. 2–4.
1925 *Lepidocyclina* (*Eulepidina*) *richtofeni* (Smith) var. *plana* Yabe & Hanzawa, p. 106, pl. 26, figs. 5–7.
1925 *Lepidocyclina formosa* Schlumberger var. *atuberculata* van der Vlerk, p. 20, pl. 2, fig. 17; pl. 4, fig. 30; pl. 6, fig. 52.
1925 *Eulepidina formosa* (Schlumberger): H. Douvillé, p. 97.
1926 *Lepidocyclina blanfordi* Nuttall, p. 334, pl. 13, figs. 5, 6, 9, 10.
1926 *Lepidocyclina* (*Eulepidina*) *andrewsiana* (Jones & Chapman): Nuttall, p. 27, pl. 4, figs. 1, 4.
1926 *Lepidocyclina* (*Eulepidina*) ? *formosa* Schlumberger: Nuttall, p. 29.
1926 *Lepidocyclina* (*Eulepidina*) *insulae-natalis* (Jones & Chapman): Nuttall, p. 30, pl. 4, figs. 2, 5, 6.
1926 *Lepidocyclina* (*Eulepidina*) *chapmani* Nuttall, p. 31, pl. 4, figs. 7–9.
1926 *Lepidocyclina* (*Eulepidina*) *inaequalis* (Jones & Chapman): Nuttall, p. 33, pl. 4, fig. 3.
1926 *Lepidocyclina ephippioides* (Jones & Chapman): Nuttall, p. 34, pl. 5, figs. 1–3, 8, 10.
1927 *Eulepidina royoi* Gomez Llueca, p. 426.
1929 *Eulepidina royoi* Gomez Llueca, p. 343, pl. 34, figs. 3–5.
1929 *Eulepidina formosoides* H. Douvillé: Gomez Llueca, p. 339, pl. 30, figs. 7–13; pl. 31, figs. 1–3.
1929 ? *Lepidocyclina* (*Eulepidina*) *formosa* Schlumberger var. *sella* Zuffardi-Comerci, p. 133, pl. 7, figs. 5, 11.
1930 *Lepidocyclina* (*Eulepidina*) *gibbosa* Yabe: Hanzawa, p. 90, pl. 26, figs. 6–9.
1930 *Lepidocyclina* (*Eulepidina*) *richtofeni* (Smith): Hanzawa, p. 88, pl. 26, figs. 1–5; pl. 27, fig. 11; pl. 28, figs. 1–13.
1930 *Lepidocyclina* (*Eulepidina*) *formosa* Schlumberger: Hanzawa, p. 90, pl. 26, fig. 13.
1930 *Lepidocyclina* (*Eulepidina*) *dickersoni* Yabe & Hanzawa: Hanzawa, p. 90, pl. 26, fig. 12.
1932 *Lepidocyclina crassata* Cushman: Scheffen, pp. 32, 33, pl. 6, figs. 1–3.
1933 *Lepidocyclina* (*Eulepidina*) *favosa* Cushman: Vaughan, p. 37, pl. 17, figs. 1–3; pl. 18,

figs. 1–4; pl. 19, figs. 1–4; pl. 20, figs. 1–3; pl. 21, figs. 1, 3, 4. This paper provides full references and synonymy for the western hemisphere up to 1933.
1934 *Lepidocyclina* (*Eulepidina*) *favosa* Cushman: Cole, p. 27, pl. 4, figs. 2, 3, 12.
1935 *Lepidocyclina* (*Eulepidina*) *favosa* Cushman: Rutten M. G., p. 540.
1935 *Lepidocyclina* (*Eulepidina*) *formosa* Schlumberger: van de Geyn & van der Vlerk, p. 234.
1937 *Lepidocyclina* (*Eulepidina*) *formosa* Schlumberger: Thiadens, p. 105.
1937 *Lepidocyclina zuffardii* Silvestri, p. 199, pl. 13 (10), fig. 6; pl. 20 (17), figs. 10, 11.
1937 *Lepidocyclina favosa* Cushman: Silvestri, p. 189, pl. 18 (15), fig. 4; pl. 19 (16), fig. 5; pl. 20 (17), figs. 8, 9; pl. 21 (18), figs. 5, 6.
1937 *Lepidocyclina formosa* Schlumberger: Silvestri, p. 196, pl. 16 (13), figs. 4, 5; pl. 22 (19), fig. 1.
1937 *Lepidocyclina formosoides* (H. Douvillé): Silvestri, p. 195, pl. 16 (13), figs. 7, 8; pl. 22 (19), fig. 2.
1937 *Lepidocyclina royoi* (Gomez Llueca) Silvestri, p. 191, pl. 18 (15), fig. 5; pl. 19 (16), figs. 2–4; pl. 20 (17), figs. 6, 7; pl. 21 (18), figs. 4, 7.
1937 *Eulepidina dilatata* (Michelotti) var. *insulae-natalis* H. Douv. [sic!]: David-Sylvain, p. 20, pl. 2, fig. 8.
1941 *Lepidocyclina* (*Eulepidina*) *favosa* Cushman: Vaughan & Cole, p. 75, pl. 40, figs. 1–4.
1942 *Lepidocyclina* (*Eulepidina*) *favosa* Cushman: Hanzawa & Asano, p. 120, pl. 9, figs. 1–4; pl. 10, figs. 1, 3, 4; pl. 11, figs. 1–5.
1942 *Lepidocyclina* (*Eulepidina*) cfr. *favosa* Cushman: Marchesini, p. 60, pl. 3, figs. 2, 3.
1942 *Lepidocyclina* (*Eulepidina*) *raulini* Lemoine & R. Douvillé: Marchesini, p. 53, pl. 1, figs. 3, 7–9.
1942 *Lepidocyclina* (*Eulepidina*) *formosoides* (H. Douvillé) var. *asimmetrica* Marchesini, p. 56.
1945 *Lepidocyclina* (*Eulepidina*) *favosa* Cushman: Cole, p. 41, pl. 4, figs. 3, 4, 7, 11.

Material. P. 40664, P. 40667, P. 40668.

Description. Test with thick central portion and thin peripheral flange, sometimes clearly demarcated from each other, sometimes continuous with one another forming a lenticular whole. The relative inflation of the central portion is extremely variable, and the test as a whole may be flat or sellate. An external pattern or ornament is formed by reticulate ridges which represent the more or less thickened walls of the lateral chambers; these are always coarser and more apparent near the centre of the test than towards the periphery or on the flange, and in extreme cases resemble the zoarium of a massive cyclostomatous polyzoan.

The equatorial chambers are large, hexagonal, or spatulate; they give the impression of being arranged in cycles. The nucleoconch is eulepidine; the large chamber seems almost entirely to surround the smaller one in correctly oriented equatorial sections. In oblique sections or in sections parallel to, but outside, the equatorial plane this character is not apparent, and there may be a false resemblance to a nephrolepidine nucleoconch.

The lateral chambers have thick walls which may give the impression of strong pillars in axial sections. Oblique sections have been described as showing anastomosing pillars; these illusions are dispelled by observation of tangential sections and exteriors, when it may readily be seen that there are no pillars and that the appearance is due to strong thickening of the walls—normal to the equatorial layer—of the lateral chambers. This thickening, though extremely variable in amount, is most pronounced near the centre of the test; in tangential sections, i.e. sections through the lateral chambers and parallel to the equatorial layer, the thickened walls may be seen in some specimens to equal in diameter the cavities of the chambers. The lateral chambers are of open appearance in vertical sections and their roofs and floors are thin.

Dimensions of Kirkuk examples. Maximum diameter, 18 mm., minimum 3 mm. Diameter of nucleoconch 0·5 mm. to 1·0 mm. Lateral chambers, 9 to 10 in a height of 1 mm. Length in vertical section, 0·1–0·35 mm.

Distribution. This species was originally described from Christmas Island (Indian Ocean), from strata thought to be most probably of Miocene age. However, it has a wide geographic distribution and may be stated quite definitely to occur in rocks of different ages in different places; its migration can be followed about three-quarters round the world.

In the western hemisphere it occurs in Lower and Middle Oligocene, and is recorded from the following countries: Mexico, U.S.A. (Florida), Cuba, Antigua (Leeward Islands), Trinidad; I have seen specimens in the Oligocene of Venezuela.

In Europe it is known from Spain, France, and Italy. Here it is associated with *Nummulites intermedius* (d'Archiac) and *N. fichteli* Michelotti, but ranges probably above the zone of these nummulites. .

In the Middle East its occurrence in Kirkuk is in the higher part of and above the beds with *N. intermedius*, but does not range far down in these beds, and is far removed from the base of the Oligocene.

In the Far East it is widely recorded, generally from beds regarded as of Aquitanian or of Miocene age. However, in the latest stratigraphical work on the Philippine Islands (Hashimoto, 1939: 385), the Binangonan limestone is correlated with the Cebu formation of the Visaya Series, which is placed in the Oligocene. Species of *Lepidocyclina* here included in *L. ephippioides* have been recorded from the Binangonan limestone.

Further precise stratigraphical observations on the occurrence of *Lepidocyclina ephippioides* will be necessary to complete the picture; but the impression of migration from Mexico via the Mediterranean and India to the East Indian Islands is inescapable, and this movement occupies at least the whole of the Oligocene.

Remarks. The chequered nomenclatural history of this variable species may be inferred from the foregoing synonymy, which is still incomplete. No doubt it would be possible to prove the existence of local races which might be distinguished as varieties; but examination of material from many parts of the world leaves me convinced that no specific distinctions are valid.

All of the supposed species in the long list of synonyms are based upon variations which are generally found in any assemblage, comprising:

(*a*) Wide variability of ratio between diameter and thickness.
(*b*) Relative development of flange and umbo.
(*c*) Width of lateral chambers and thickening of walls between them.
(*d*) Sellate distortion of the test.

Hanzawa & Asano (1942: 121–123, including table of dimensions) have taken pains to demonstrate certain distinctions between *Lepidocyclina formosa* and

Lepidocyclina favosa, namely, absolute diameter (*Lepidocyclina formosa* is from 2 to 4 times as large as *L. favosa*), and ratio diameter/thickness (see below):

	Megalospheric	*Microspheric*
L. formosa . . .	1·7:1–3·2:1	2:1–3:1
L. favosa . . .	2·2:1–5·7:1	6:1–11:1

(After Hanzawa & Asano.)

This latter divergence between the ratios diameter/thickness would be more convincing if it were not correlated with differences in diameter; or in other words, the young of *Lepidocyclina formosa* may still be indistinguishable from the adult *Lepidocyclina favosa*. Now difference in size could itself be correlated with a difference in the latitude of provenance, could in fact be purely a matter of more or less favourable environment. From this I would infer that distinction between these species is not proven and is better not maintained. There remains, however, the possibility that geographical or stratigraphical races may eventually be found to merit recognition in a varietal status only.

The rules of priority seem to point to *Lepidocyclina ephippioides* as the earliest applicable name of the species, which is therefore adopted here. The Kirkuk specimens would all qualify for inclusion in *Lepidocyclina favosa* rather than in *L. formosa* were the distinction between these species to be upheld.

The fundamental characters of the species—hexagonal or spatulate equatorial chambers, eulepidine nucleoconch, lack of pillars, but thickening of lateral chamber walls visible in varying degree—remain stable amid all the extremities of variation of the remaining characters. *Lepidocyclina ephippioides* resembles *L. dilatata* as far as the equatorial layer is concerned, but differs in not having pillars and in the thickening of the walls of the lateral chambers. In general, it is stouter than *L. dilatata*, but this character is gradational. *Lepidocyclina elephantina* usually possesses 'buried' pillars which fail to reach the surface; the lateral chambers are small and with unthickened walls.

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Note on *Spiroclypeus* (p. 238).

The species *Spiroclypeus vermicularis* Tan, from the Eocene of East Borneo, is certainly identical with or very closely related to the form here described as *S. anghiarensis* Silvestri; but see Tan Sin Hok (1937: 187, pl. 1, figs. 7, 8; pl. 2, figs. 6–10; pl. 3, figs. 13–23; pl. 4, figs. 11–18).

PLATE 20

FIGS. 1–6. *Heterillina hensoni* sp. nov.

1. Transverse section, cutting the initial chamber: shows inner wall of later chambers strongly thickened to form the 'platform', × 20. Specimen lost.
2. Transverse section of syntype, showing 'platform', × 20. P. 40680 (i).
3. Tangential section of syntype, cutting the aperture, and showing the trematophore, × 30. Specimen destroyed in remounting.
4. Longitudinal section of syntype, cutting the initial chamber, and showing thickening of inner walls of later chambers, × 20. P. 40680 (ii).
5. Oblique section of syntype, cutting the initial chamber, × 20. P. 40679.
6. External view of syntype on rock chip, × 20. P. 40682.

All the above specimens are from the Oligocene of Kirkuk, well 14.

FIGS. 7–10. *Austrotrillina* (?) *paucialveolata* sp. nov.

7. Oblique section of syntype, × 30. P. 40688.
8. Oblique section of syntype, × 30. P. 40689 (i).
9. Tangential section of syntype, showing alveoli near surface of test, × 30. P. 40689 (ii).
10. Transverse section of syntype, which just misses the initial chamber, × 20. P. 40681.

All the above specimens are from the Oligocene of Kirkuk, well 14.

FIGS. 11–14. *Idalina sinjarica* sp. nov.

11. Longitudinal section of small example. The specimen shows what appears to be a vestibular structure at the apertural end of the last chamber (but this is barely visible in the photograph), × 20. Syntype P. 40708.
12. Transverse section of syntype showing initial chamber and early milioline coiling. P. 40706.
13. Longitudinal section, slightly off centre, of syntype. Shows indications of vestibular structure at apertural end of last chamber, × 20. P. 40707.
14. Transverse section, slightly oblique, of syntype; shows quinqueloculine early coiling around initial chamber, × 20. P. 40672 (ii).

All the above specimens are from the Paleocene–Lower Eocene Sinjar Limestone of Jebel Sinjar, N. Iraq.

FIGS. 15–21. *Eorupertia incrassata* (Uhlig) var. *laevis* var. nov.

15. Section, in plane of coiling, of syntype from Ain Zalah, well 1, × 20. P. 40696.
16. External view of dorsal (attached) surface of specimen from a well in Arabia, × 15. P. 40704.
17. External view of ventral side of specimen from a well in Arabia, × 15. P. 40705.
18. Lateral aspect of the specimen seen in Fig. 16, × 15. P. 40704.
19. Oblique section of syntype from Ain Zalah, well 1, × 20. P. 40697.
20. Section, in plane of coiling, of specimen from Ain Zalah, well 1, showing lumen between outer and inner whorls, × 20. P. 40695.
21. Vertical section of specimen from Butmah, well 1, × 20. P. 40701.